

SUBJECT: The Influence of CSM-103  
Hypergol Subsystem Lifetimes  
on C Prime Mission Launch  
Opportunities - Case 320

DATE: September 26, 1968

FROM: C. H. Eley III

ABSTRACT

The program which MSC is conducting to demonstrate the capabilities of the spacecraft hypergolic subsystems to remain in a "wetted" condition for a period of up to 90 days will not be completed until several months after AS-503/CSM-103 is scheduled to launch. Since hypergolic loading is scheduled to begin at T-19 days before launch, a nominal 8-day mission would leave only 3 remaining days for contingencies--which would actually be the total launch opportunity.

In view of the space vehicle recycle requirement, the probabilities are very low that a 3-day launch opportunity could support more than a single launch attempt for a C Prime Mission whether it is lunar orbit, lunar swingby or low earth orbit. If a C Prime alternate (lunar orbit) mission is flown, the decision to extend (waiver) the hypergolic compatibility lifetimes narrows down to a choice of whether or not a one or two launch opportunity capability is desired. The following are the alternatives:

a. For a C Prime (Alternate) Mission, the hypergol compatibility lifetime would have to be extended at least 4 days to fully cover the daylight launch opportunity in December 1968.

b. For a C Prime (Alternate) Mission, the hypergol compatibility lifetime would have to be extended at least 32 days to fully cover both daylight launch opportunities for December 1968, and January 1969.

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MEMORANDUM FOR FILE

The program which MSC is conducting to demonstrate the capabilities of the spacecraft hypergolic subsystems to remain in a "wetted" condition for a period of up to 90 days will not be completed until several months after AS-503/CSM-103 is scheduled to launch. Hence, CSM-103 is limited by its current design exposure lifetime of thirty days unless an extension is obtained through a waiver from MSC. There is good reason to believe that MSC can grant such a waiver to extend the compatibility without a major perturbation of their test program. The question, however, is how much extension will be required to adequately support the C Prime Mission (including alternates).

NATURE OF HYPERGOL COMPATIBILITY CONSTRAINTS

The compatibility constraint of concern is prolonged exposure of the CSM propulsion subsystem to hypergolic propellants in either liquid or vapor form.\* The hypergol propellants/vapors involved are Monomethylhydrazine (MMH), Aerozine 50 (A-50) and Nitrogen Tetroxide ( $N_2O_4$ ). Since  $N_2O_4$  (vapor or liquid form) in the presence of moisture forms nitric acid, it is the more degrading to the subsystem.

An example, for instance, with which CSM-103 would be faced concerns the SPS pressurization panel which is continuously exposed to propellant vapor any time the tanks are loaded. In this case, the problem is propellant vapor backstreaming (by leakage) through the quad-check valves. If backleakage does occur, and it can, a reaction in the common crossover manifold will produce water. This water will combine with  $N_2O_4$  vapor to form nitric acid which, in turn, absorbs more water from the vapor reaction producing dilute nitric acid. The dilute nitric acid can remove the anodize of the aluminum housing, eventually resulting in the formation of aluminum nitrate crystals (particulate contamination).

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\*"Compatibility Evaluation of CSM SPS and RCS Hardware,"  
MSC report by Propulsion and Power Division, dated May 31,  
1968

While the CSM propulsion subsystems have only been formally qualified to 30 days, this does not necessarily mean that difficulties can be expected to occur on the 31st day after propellant loading. Actually, the subsystems are probably capable of remaining wetted for a period well over 30 days, which is one of the MSC objectives--establishing the upper limits of subsystem compatibility in their current program.

#### COMPATIBILITY REQUIREMENTS TO SUPPORT THE C PRIME MISSION

##### A. Current Launch Opportunity

Until recently, hypergol loading for AS-503/CSM-103 was scheduled to begin about 10.5 days before the launch based on a "success" schedule. As shown in Figure 1, the AS-503 CDDT has been shifted in the pad schedule to occur after hypergol propellant loading.\* The effect of this change is to move the start of hypergol loading from T-10.5 days back to T-19 days in the pad schedule. It should be noted that, as before, the 19 days also comprises a "success" schedule. Adding a nominal mission time of 8 days to the 19 days of hypergolic exposure gives a total minimum time of 27 days during which the spacecraft propellant subsystem would be in a "wetted" condition. Any schedule slippages after the start of hypergol loading would, of course, increase this figure. Based on a 30-day exposure lifetime, the maximum time, then, available for contingencies after T-19 days would be the difference between minimum exposure time and the 30-day design point--which is 3 days. This relationship is shown in Figure 1. If CSM-103 hypergol compatibility remains at 30 days, schedule slippages after the start of hypergol loading totaling more than three days will correspondingly reduce the time available for the mission.

For AS-503, the importance of this "contingency time" available after the start of hypergol loading is that, in reality, this is the total launch opportunity.\*\* If AS-503 is to conduct a mission requiring "date specific" software, this contingency time could well be a determining factor in the number of launch windows to prepare for.

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\*AS-503 LC-39 Processing Schedule, KSC, dated September 10, 1968

\*\*A "launch opportunity" is defined as the total period of time within a given month during which the daily launch windows occur.

1. Impact of SV Recycle Requirements

Current Apollo/Saturn recycle requirements for a scrub after LV cryogenics have been loaded are in excess of two days. A 3-day launch opportunity, therefore, for AS-503 under the conditions outlined above is insufficient to accommodate more than one launch attempt for an eight-day mission. These conditions would apply to any 8-day C Prime Mission whether it is lunar orbit, lunar swingby or low earth orbit. Given the types of schedule slippages experienced in the past, the probability may be low of successfully meeting a three-day launch opportunity from a point in the pad flow 19 days prior to launch.

- B. Compatibility Extension for C Prime Mission (Alternate) Launch Opportunities

Current planning for AS-503/CSM-103 is to conduct an 8-day lunar orbit mission (C Prime Alternate) predicated on the successful flight of AS-205. In this case, the mission will fall within an MSC ground rule which states that the first lunar orbit mission will be launched in daylight.\*

1. Single Launch-Opportunity Capability

Under the ground rule mentioned above, the first available time period (launch opportunity) within range of the current MSF schedule is from December 20-27 of this year.\*\* Realizing that present launch opportunity availability for AS-503 is only three days, a 4-day extension of the hypergol compatibility is required to fully cover this opportunity (see Figure 2).

2. Dual Launch-Opportunity Capability

In the event a two launch opportunity capability is desired for an alternate C Prime Mission (Pacific injection only), the next opportunity after December when daylight launch windows occur during the period of January 18-26, 1969. The CSM compatibility lifetime would, therefore, have to be extended at least 32 days to cover this period. This relationship can be seen graphically in Figure 2.

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\*Also included in Apollo/Saturn Launch Mission Rules, Apollo 8 (AS-503/CSM-103) (Preliminary)

\*\*Preliminary Mission Implementation Plan for Apollo 8, C Prime Mission Apollo Program Office, NASA Headquarters, dated September 3, 1968

CONCLUSIONS

Given an 8 day C Prime Mission, it is concluded that:

a. A 30-day hypergol compatibility lifetime for the CSM propulsion subsystems limits the C Prime Mission to a 3-day launch opportunity.

b. The compatibility lifetime would have to be extended somewhat to increase the probability of launch success.

c. For a C Prime (Alternate) Mission, the compatibility lifetime would have to be extended at least 4 days to fully cover the daylight launch opportunity in December 1968.

d. For a C Prime (Alternate) Mission, the compatibility lifetime would have to be extended at least 32 days to fully cover both daylight launch opportunities for December 1968, and January 1969.

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Attachments  
Figures 1-2

ACKNOWLEDGEMENT

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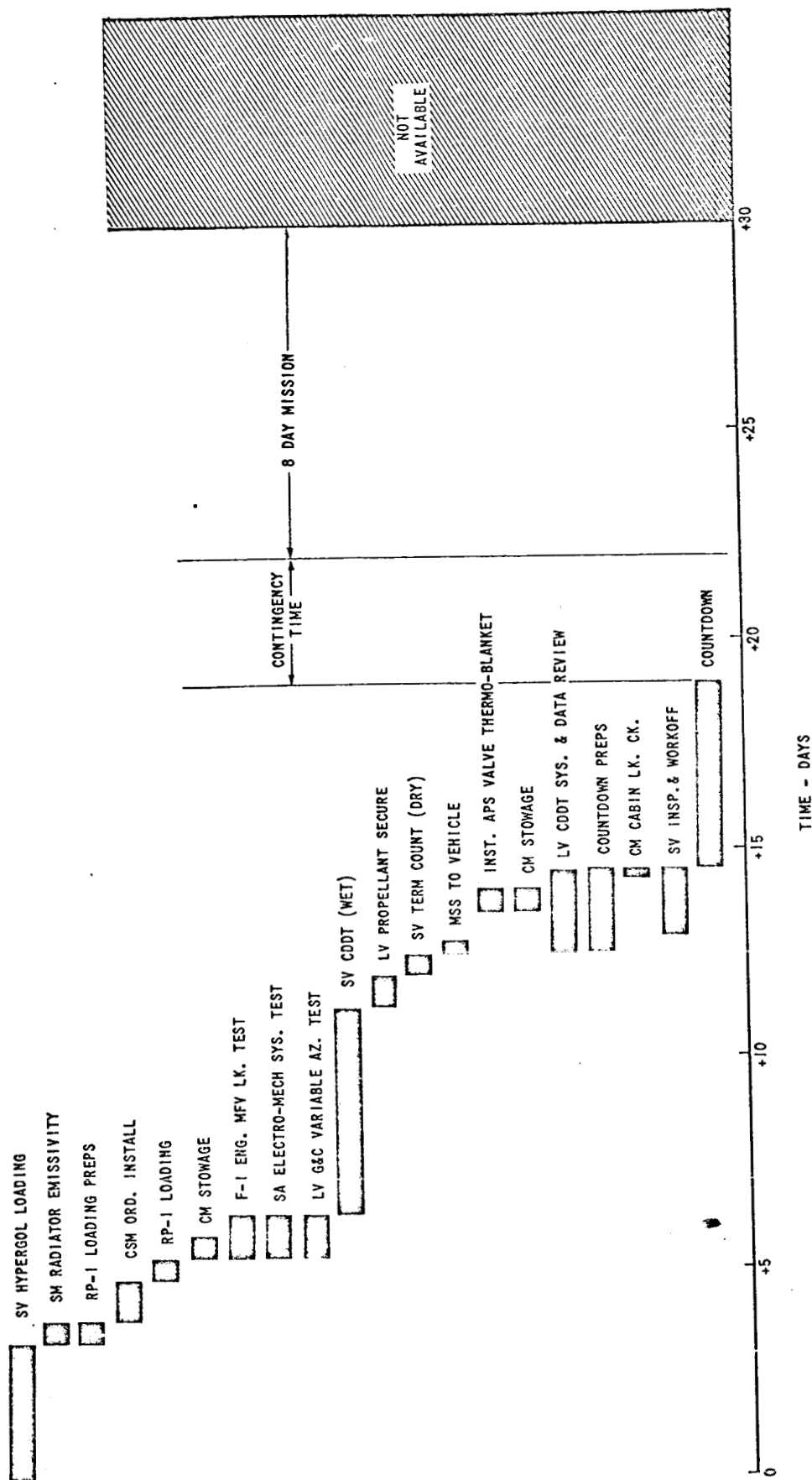


FIGURE 1 - AS-503 TEST FLOW WITH AVAILABLE CONTINGENCY TIME AFTER START OF HYPERGOL LOAD (BASED ON A 30-DAY SUBSYSTEM LIFETIME COMPATIBILITY)

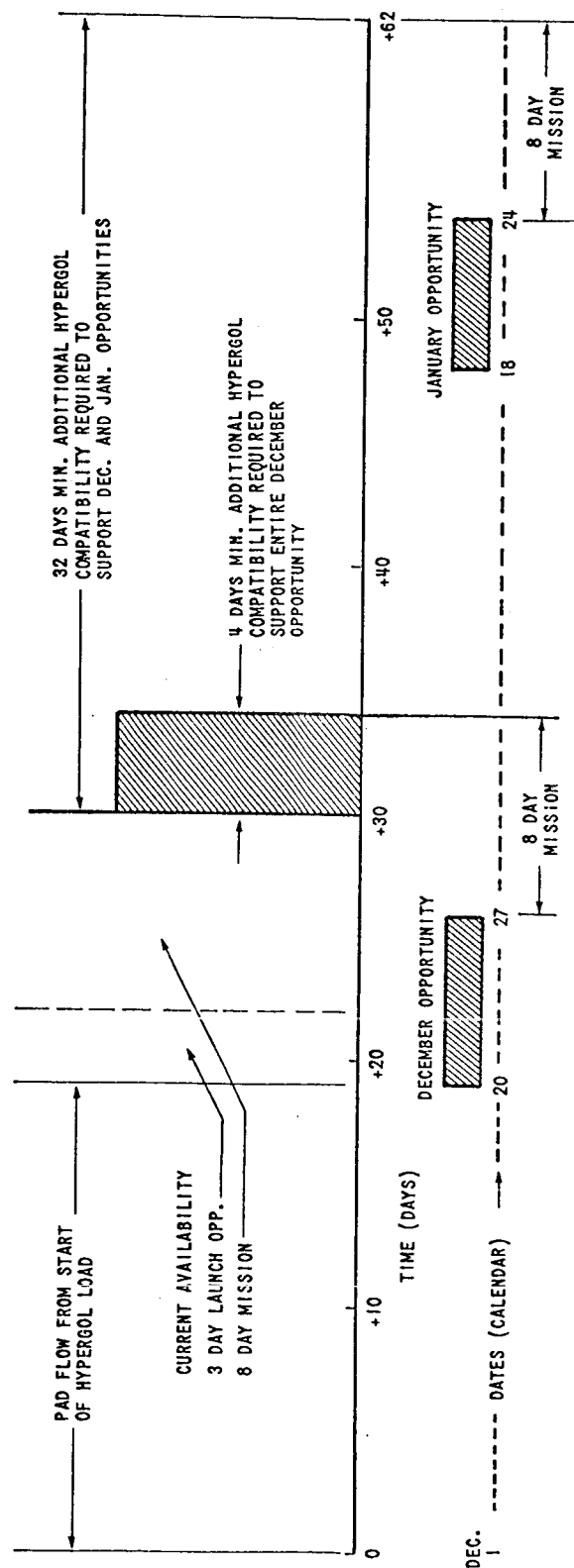


FIGURE 2 - AS-503 TIME RELATIONSHIPS SHOWING ADDITIONAL HYPERGOL COMPATIBILITY REQUIRED TO SUPPORT A COMPLETE DECEMBER OPPORTUNITY OR BOTH DECEMBER AND JANUARY OPPORTUNITIES

BELLCOMM, INC.

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